ISAC Science Forum, 2005-02-02

Present:

Friedhelm Ames, Andrei Andreyev, John Behr, Pierre Bricault, Lothar Buchmann, Jac Caggiano, Thomas Cocolios, John D'Auria, Barry Davids (BD), Paul Delheij, Jens Dilling, Marik Dombsky, Andy Hurst, Dave Hutcheon, Marc Huyse, Peter Jackson, Rituparna Kanungo, Jens Lassen, Bob Laxdal, Phil Levy, Colin Morton, Jean-Michel Poutissou, Chris Ruiz, Mike Trinczek, Jim Waddington, Pat Walden

Notes taken by GH

EMMA Review: Barry Davids

BD reported on the EMMA NSERC site visit, reviewing the agenda and committed membership. The committee reported that the science case was strong, and that in fact, many of the best experiments one could expect to do at ISAC-II are **not** possible without EMMA. The committee noted that the design had no major technical risks, and incorporated many important improvements on existing E-M-E designs that were well suited to ISAC-II. The committee appreciated that the recommendations of the June technical review were followed carefully. The committee was also impressed by the representation of young scientists and the strong support of TRIUMF management. BD also noted that the committee had been charged to explore "reduced funding" scenarios and appreciated detailed budget discussions.

LB asked about the questions posed by the GSC that were to be addressed at Large Projects Day in Ottawa. BD responded to two specifically, namely that he would be clarifying the apparent discrepancies in personnel hour commitments and how DAQ would be integrated. Subsequently there was much discussion by GH, JL, JD, PW, and KPJ about how the DAQ system would be based on work done for TIGRESS through LADD.

Diagnostic Device for MEBT: Chris Ruiz

CR discussed a proposal to install an elastic backscattering apparatus in MEBT to discriminate high-mass, multiply-charged stable beams from low-mass singly-charged ions or molecular ions, specifically considering $^{40}Ca^{++}$ vs. $^{20}Ne^{+}$, FH^{+}. Details are given in the attached document. It was expected that eventually this diagnostic would be operable by ISAC operators.

Highlights of subsequent discussion: It was clear that single-mass discrimination would not be possible (e.g. to ^{20}Ne vs. ^{19}F from ^{19}FH breakup), but LB pointed out that one would observe the H. It was mentioned that it would be worth it to see if there was indeed a solution that could give single-mass discrimination. The device would fit in an 8" cube on the 0 degree line after the first RFQ. Some quadrupoles would have to be retuned for this line as opposed to sending the beam to the accelerator, but REL noted that no new optics elements were needed. Rates of 50 Hz in the scattering detector would be expected. It was suggested that a more sophisticated and powerful end station (e.g, with a Ge detector) would be desirable for radioactive beams; however, DH contended that well defined "present problems" should be the focus. The diagnostics cannot go at the end of the Prague magnet. An E-dE telescope at the end of the ISAC-II beamline is needed

Target, Ion Source & Experiment Schedule: JMP

JMP presented a possible schedule of targets and ion sources. Two possible scenarios were discussed, with the only difference being early in the schedule. The first scenario presented would have a high-power target with Ta installed and producing beam through April, while the second scenario saw a short test with a high-power SiC target for about two weeks at the end of March followed by three or so weeks with a regular-power Ta target. After that would be running

with the ECR and a $CaZr0_3$ target in late April and May, then SiC on the high-power target with the laser ionizer configured for Al beams in June. The ECR source would be used again in July, then normal Ta in August, leading into the September mini-shutdown.

In terms of experiments planned for these production targets, one question that was raised was whether or not TUDA would be ready for an experiment at that target location in late March and early April, and collaboration members said “yes”. It was noted out that we shouldn’t be trying new things when a lot of key people are on summer vacation. GCB pointed out that one experiment from last summer involving overseas scientists went very poorly, in part because many key people were on vacation and not available to make sure that we provided them with what they needed for their experiment to succeed. Febiad development was discussed; PB identified that manufacturing of the tray was the biggest potential time risk and that the febiad needs shop priority. Laser tests could be done in May but this could only be confirmed when the laser is delivered. Dragon collaborators were asked about whether or not they could run with higher ^{26g}Al yield at any cost; in particular, could they run with higher 26gAl yield even if the 26Na contamination level was the same as last year’s attempt. The response was that higher yield with the same Al/Na ratio would be very good. AH pointed out that there could be a problem installing the Ta target in the second scenario as that would conflict with vacation time for target people.

Other business:

JMP introduced Marc Huyse, who is on sabbatical from KU Leuven. He is in a cubicle in the Cyclotron Division suite (MOB 2nd floor, north wing, east end).

Next forum on 16 Feb will have rehearsals of student talks for the Western Regional.

An Elastic Scattering device for MEBT

● Recent requirement for stable beams from OLIS to DRAGON of relatively high mass for ISAC e.g: ^{40}Ca, ^{28}Si, ^{29}Si

● In these cases M/Q ambiguities can arise leading to confusion in beam identification and delays in delivery

e.g: $^{40}Ca^{++}$ required for RFQ
$^{20}Ne^{+}$ or FH^{+} may contaminate

● M/Q ambiguity normally resolved after MEBT bending magnets
→ stripper required to provide high enough charge states to bend (and be accepted by DTL)
→ faraday cup prior to DTL read against bending magnet current to identify mass peaks

Problems:

● multiple charge states → multiple peaks

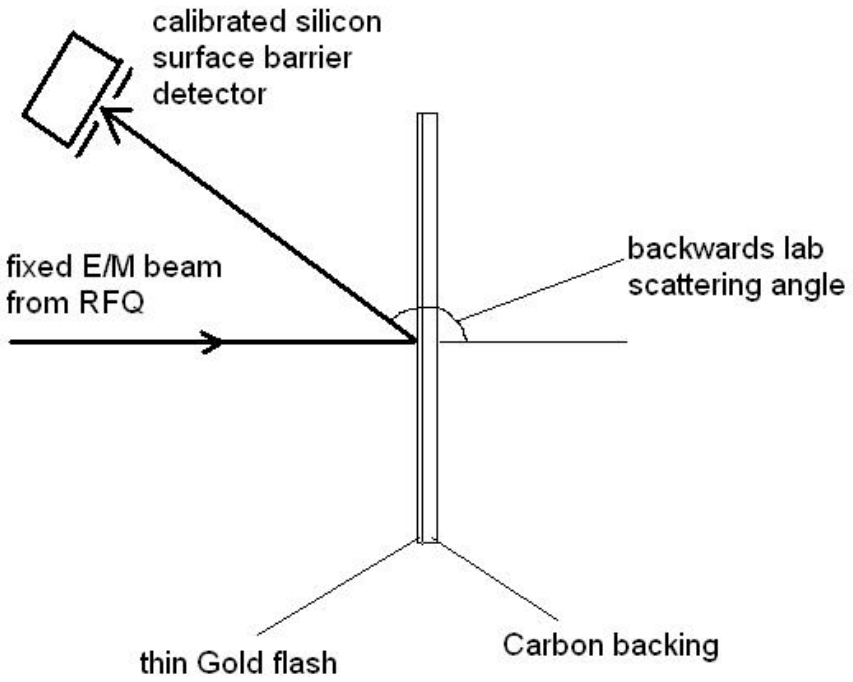
● focus depends on quadrupole field strengths in MEBT, so simply varying the magnet current produces one focussed reference peak and other peaks are smeared out

● this all takes time – in the case of ^{40}Ca it took over an afternoon to determine that the current from OLIS was NOT ^{40}Ca!

Proposal:

An elastic scattering device in MEBT which will quickly discriminate between low-mass, high-mass and molecular beam components of the same M/Q, without the need for bending magnets

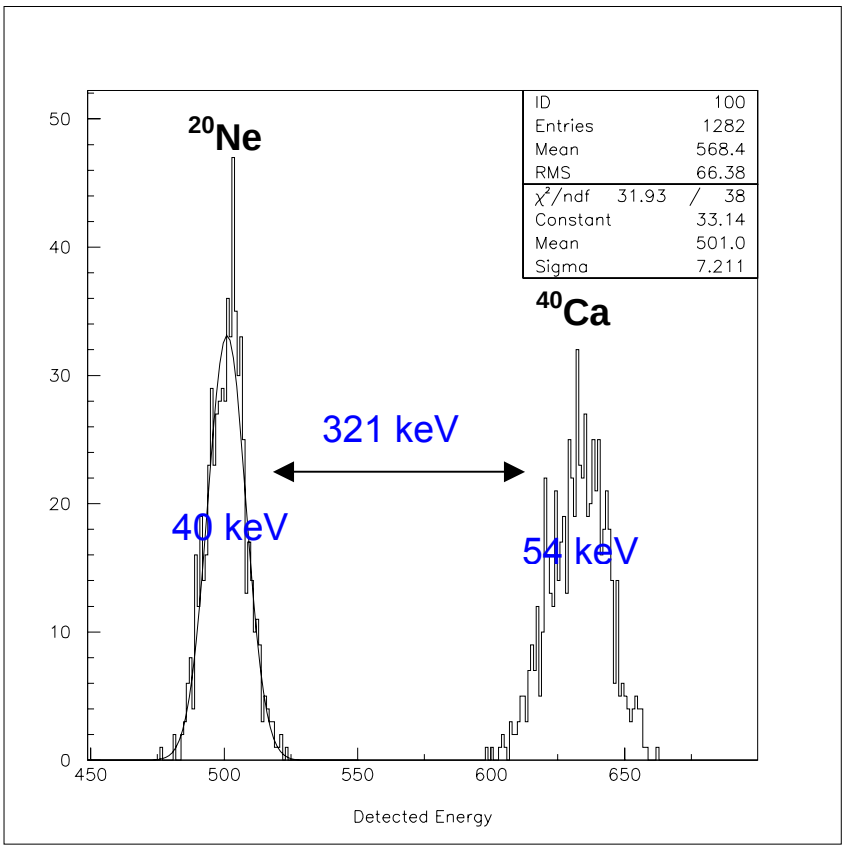
Principle:



● backwards scattering advantages:
- no recoils beyond 90º, so # peaks = # beam components
- kinematics vary slowly with angle in backward hemisphere

● disadvantages:
- low cross-section compared to forward angles

● Use of Gold:
- relatively large cross-section
- can be evaporated as very thin layer, minimizes energy loss
- backing can be thick and robust (and inverse kinematics)



● simulation includes energy loss and straggling in target and detector deadlayer, plus pulse-height defect for a 1 cm^2 detector at 5 cm from the target and a lab angle of 150º. A 4 mm beamspot was simulated.

● separation determined by mass difference, energy loss in detector deadlayer and pulse-height defect

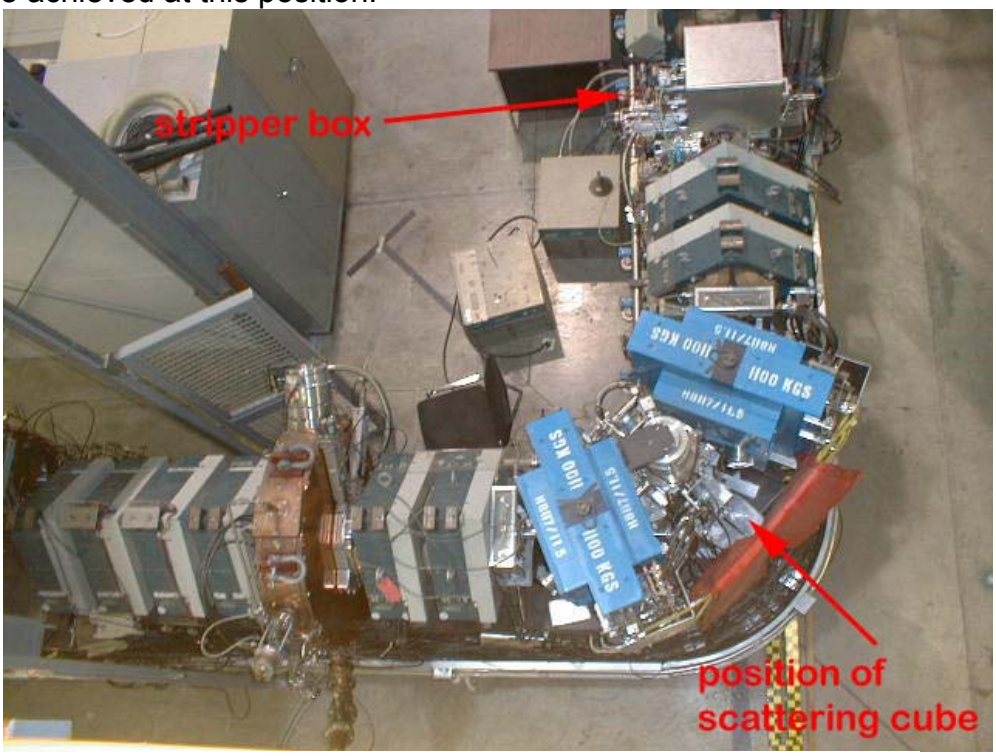
Rates:

For a 6 mm diameter collimated detector at 7 cm and 150º, with a 5 $\mu g/cm^2$ gold flash, the rates for ^{40}Ca and ^{20}Ne scattering would be of the order 50 Hz/pnA

Operation:

After commissioning, ISAC operators could be provided with a table of calibrated energies allowing them to collect a spectrum (EPICS readout) over several minutes and identify the peaks

Positioning:
- A standard 8-inch cube would hold target ladder, detector, and faraday cup.
- No space upstream of the stripper box. However, the 0º line (future ISAC II) after the first bender is an ideal place.
- Magnet can be switched off. No stripper required → blank position on stripper chain.
- Trace3D simulation by Marco Marchetto shows that better than 1.5 mm focus can be achieved at this position.



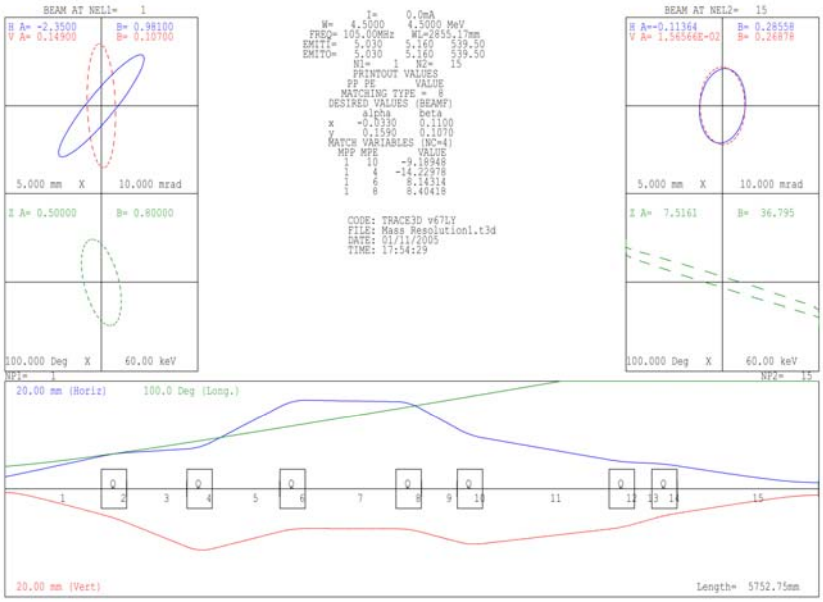


Figure 2. TRACE 3D simulation of all 7 quadrupoles after the RFQ.

Equipment & Costs:

Vacuum cube & fittings (faraday cup etc)	
Targets	
F Series Heavy-Ion Partially Depleted Silicon Surface Barrier Detector	$ 595.00
Ortec 142B Preamplifier	$ 1,360.00
428 Detector Bias Supply	$ 1,750.00
4006 Minibin and Power Supply	$ 2,855.00
Amptek Pocket MCA	$ 4,837.79
CAL2500 MEMIX 3, 3 nCi Pu-239, Am-241, Cu-244 Calibration source	$ 2,047.54
Cost for miniumum configuration before tax (Ninc. Vacuum box, targets etc)	$ 13,445.33

Report on NSERC Review of EMMA

Barry Davids

TRIUMF

Review

- Took place 17-18 December 2004
- Intro by JMP, project overview by BD
- Science Programme described by Carl Svensson (structure), Rituparna Kanungo (reactions), BD (astrophysics)
- Overview of ISAC-II by Rick Baartman
- Spectrometer design presented by BD
- Integration of TIGRESS & EMMA discussed by Roby Austin
- DAQ issues described by Chris Ruiz
- Budget and timetable presented by Dave Hutcheon

Review Committee

- Noemie Benczer-Koller, Rutgers University
- David Radford, Oak Ridge National Lab
- Darek Seweryniak, Argonne National Lab
- Kumar Sharma, University of Manitoba
- Bob Tribble (chair), Texas A & M University
- Antonio Villari, GANIL
- Sandra Zohar, NSERC

Report Executive Summary

- Science case judged very strong
- Committee appreciated report of June Technical Review
- No major technical risks
- New information on budget presented at review was used for financial recommendation
- Very impressed by strong support of TRIUMF management

Science Case I

- With planned improvements in targets and ion sources, TRIUMF will be a premier RNB facility for at least the next decade
- EMMA will be an integral part of ISAC-II
- Many of the most important and exciting ISAC-II experiments will be impossible w/out EMMA, e.g., single-nucleon transfer reactions in inverse kinematics w/ ^{132}Sn, ^{100}Sn, ^{78}Ni
- Two-nucleon transfer reactions will allow study of pairing, e.g., (t,p), (^{3}He,p), (p,^{3}He)

Science Case II

- Heavy-ion fusion-evaporation reactions with proton-rich or deficient RNB's a natural way to produce highly exotic nuclei
- Species of interest produced with very small probability in presence of many competing channels
- RNB's ensure huge σ gain relative to stable beams (10^4), but low intensities mean efficient, selective detection system required
- EMMA, w/ its large angular acceptance and very good mass resolution, is ideally suited to this task
- With TIGRESS, can address mirror symmetry in N~Z nuclei, & w/DSSD studies beyond the p drip line

Science Case III

- Nuclear astrophysics programme of DRAGON and TUDA can be extended with EMMA
- Time-reversed (α,p) reactions with TUDA
- EMMA mandatory for study of n-rich nuclei for r process
- Complete nuclear spectroscopy below particle emission threshold with TIGRESS
- EMMA can even be used alone, e.g., in sub-barrier fusion studies
- Combination of EMMA, TIGRESS, & TUDA will place ISAC-II in world leadership position in RIB science

Technical Details I

- EMMA well-suited to the energy and mass ranges of ISAC-II
- RMS designed to separate recoils from beam and disperse according to m/q
- Design similar to existing EME spectrometers
- Important improvements included in design
- Angular acceptance twice as large as ANL FMA, very desirable for RNB facility
- Major gains in this due to 1st quad; feasibility of its construction confirmed by potential manufacturer
- Committee noted that 3rd order GIOS calculations verified by ray-tracing results exact to all orders

Technical Details II

- Committee considers proposed design state-of-the-art, yet foresees no difficulties with its implementation
- NSERC committee appreciated excellent and thorough technical review carried out in June
- Noted that recommendations were closely followed
- Concurs with technical review committee's strong endorsement of design

Technical Details III

- Focal plane detectors are an integral part
- Committee considers the proposed position-sensitive proportional counter and ionization chamber adequate, but recommends the addition of a large-area Si detector for greater flexibility and ease of operation
- Addition of DSSD for recoil decay tagging experiments would greatly enhance capabilities, but could be considered for funding as a separate system
- Goals of project can best be achieved through digitizing FP detector signals with TIGRESS TIG modules, particularly for the DSSD and integration with auxiliary systems

Personnel

- Committee impressed by the presentations from very talented young investigators
- Instrumentation for facility being developed by the young people who will be using it for experiments: bodes well for Canada
- Proponents are ideally situated to train the next generation of Canadian students, who are likely to find the science of TIGRESS, TUDA, and EMMA very attractive